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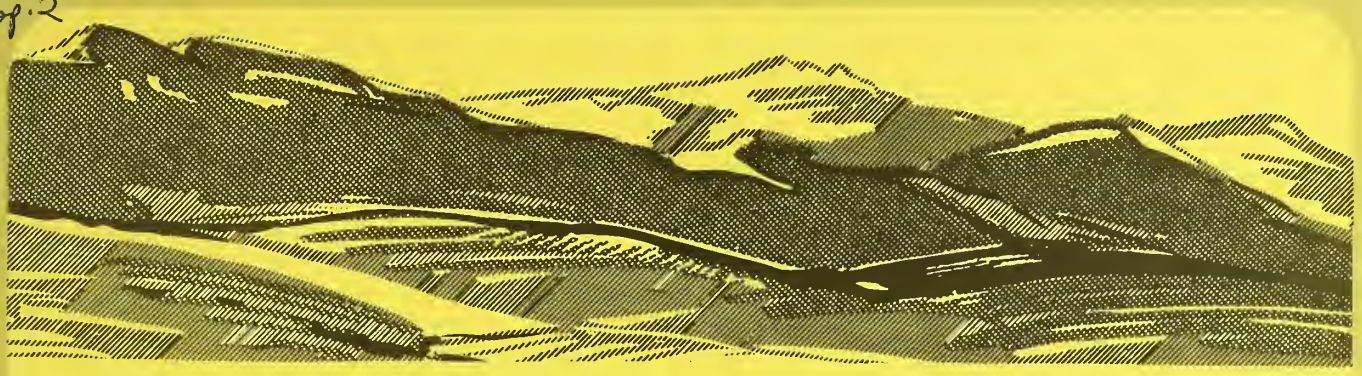

RANGE IMPROVEMENT NOTES

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FOREST SERVICE — U. S. DEPARTMENT OF AGRICULTURE
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STATEMENT OF PURPOSE

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This publication is printed primarily to inform professional range administrators of important range improvement and management developments and findings. These "NOTES" may include extracts of published papers, unpublished preliminary reports of research work, unpublished reports on administrative studies and personal observations or suggestions of other range administrators. No claim is made as to the accuracy or completeness of studies or conclusions drawn.

All who read these RANGE IMPROVEMENT NOTES are encouraged to submit material for publication, or suggestions for improving its usefulness. Full credit will be given for any material used.

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SMALL PIPELINES FOR RANGE WATER DISTRIBUTION

By
W. H. Valentine*

The key to successful utilization of western rangeland forage resources by cattle and sheep is water. An adequate supply of clear, clean, potable water is absolutely essential before the forage resources of any given area of rangeland can be fully and economically utilized. The availability and distribution of water resource is a particular problem dealing with hydrology, hydraulics, economics, range management, and other factors, which must be considered before a balanced system can be intelligently planned and developed.

Water Quantity - Basic to any preliminary study of water distribution is a determination of the quantity of water available. Many springs and seeps yield barely enough water for development. In some cases the water quantity available from any given source does not warrant an investment in extensive distribution works. Thus, for any particular water development, the first criteria to be studied and determined is the quantity of water available for utilization.

Water Quality - Generally speaking, water quality presents no particular problems on Nevada Forest ranges. However, the possibility of water quality problems should not be ignored. Dangerous concentrations of sodium and magnesium sulfates, sodium chlorides, and other salts can and should be checked for.

Quantity for Consumption - A distinction should be made at this point between total quantity of water available and quantity of water needed for consumption. The first is criteria of project feasibility, and the second is criteria of project design. The amount cattle drink on any particular day is governed by such things as temperature, humidity, forage moisture, health of the animal, and other factors. As a design value, we have used twelve gallons per head because of our high elevation ranges. This figure is probably too low for some of the lower, hotter, drier desert sites. A figure of up to 15 gallons per head per day has been suggested for lower elevation ranges.

In our experience, we have determined that a flow rate per trough serviced of about two gallons per minute (3,000 gal./day) under a trough density of five troughs per square mile, is a desirable maximum; and that flow rates of less than one gallon a minute can be acceptable,

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depending on factors such as trough size and spacing, number of cattle served, and other storage available. Excessive flow rates contribute to waste and are to be avoided.

The following discussion will relate design and construction aspects of a small diameter pipeline in a gravity pressure system utilizing polyethylene plastic pipe.

Selection of Pipe Size - Since these distribution systems are often several miles in total extent, it is prudent economics to select the cheapest pipe that will adequately serve the flow requirements of the system. Small unit cost differences in pipes of varying diameter, when multiplied for lengths on the order of five to ten miles, soon amount to quite a figure. For example, inch pipe costs 4.7 cents per foot, whereas inch and one-quarter pipe costs 8.1 cents per foot, (from Government sources of supply). This 3.4 cents per foot difference, in five miles, amounts to almost $900. At the other end of the scale, it is not good engineering practice to design systems in such a manner that the full capacity of the pipe cannot be utilized. Neither is it prudent to develop a system with excessive flow rate, since a waste of the water resource can result. A pressure system must be designed in order to fully utilize pipe capacity. Because of site topography, installation methods, and other factors, pipe that could normally deliver, say ten gallons a minute under pressure, may have flow restricted to quite a bit less than this amount. This represents a waste in material quantity that must be avoided. Air binds caused by the more rapid headloss, for any given flow condition, than there is available head are the chief cause of restricted pipe flow.

A comparison of the hydraulic grade line to the ground profile is necessary for determination of pipe size. This, of course, calls for a survey of some nature to determine the ground profile. We have utilized several methods of survey ranging from high-type controlled field surveys to rather loosely controlled photogrammetric surveys. The type and precision of the survey that is necessary is determined by known factors of topography. For example, if there is a long distance to be traversed with small elevational difference and many "ups and downs," then a good survey is called for. However, if the same distance is over a precipitous slope, generally concave in aspect, a more loosely controlled photogrammetric survey can be utilized. We have successfully designed systems utilizing a KEK third order plotting instrument and 1:15, 840 nominal scale aerial photography with elevational control taken from altimetry

measurements. The project itself determines the extent of survey. As I mentioned, a comparison of the ground profile with the hydraulic gradeline to determine pipe size for predetermined flow is necessary.

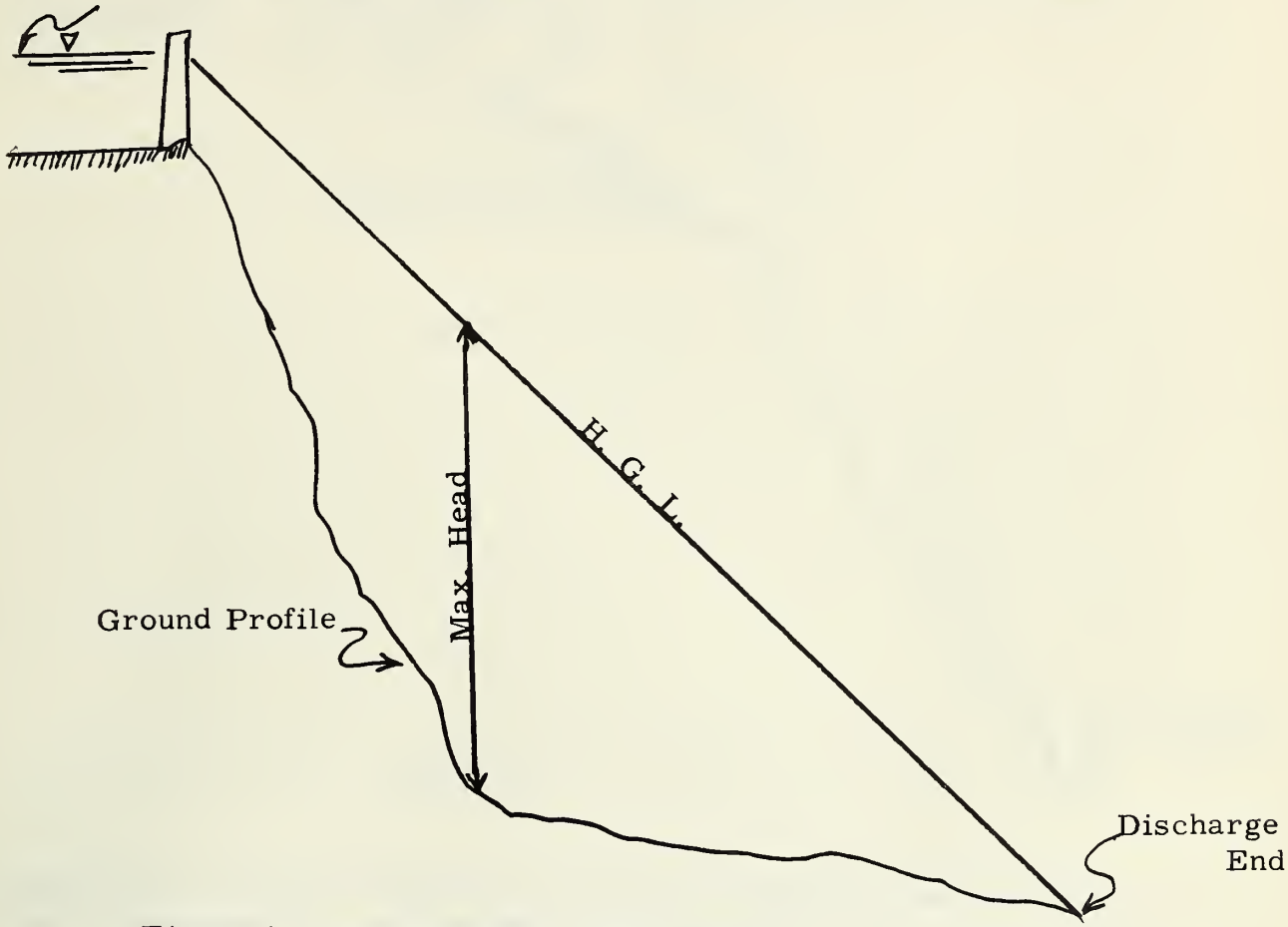

Figure 1. Free flowing, uniform pipe.

Figure 1 illustrates the headloss in a pipe of uniform size with uniform characteristics that govern the discharge. If the pipe is open-end, the hydraulic grade line drops uniformly from the surface of the fluid at the inlet end to the center of the discharge stream at the outlet end. With topography as is represented by the ground profile in Figure 1, this is a satisfactory arrangement. Notice the more or less concave ground topography and the fact that everywhere the pipe is below the hydraulic grade line.

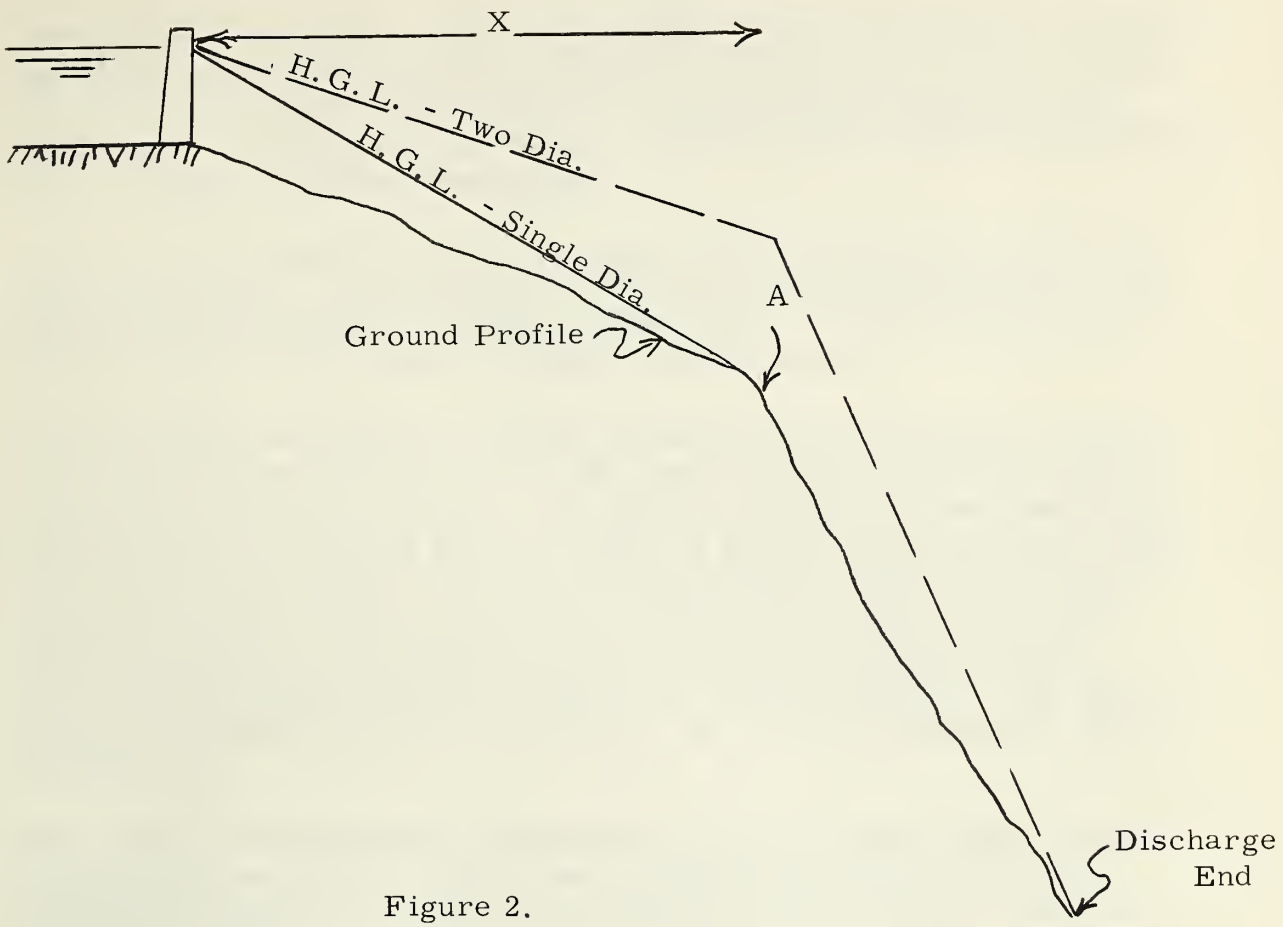

Figure 2.

Sometimes a situation occurs as is pictured in Figure 2, where the ground profile is not concave, but rather convex in shape. If the pipe of uniform size were used, a flow constriction would occur at the summit point A. This is a siphon. Since the pipe is above the hydraulic grade line, a situation of negative pressure develops. Since such a condition cannot long endure under any given flow condition, air bubbles will collect and the pipe will not discharge its full capacity.

What is needed is a design, in this case, that either relocates the pipeline to avoid the airlock at A, or changes the available head at A. The latter can be done by installing the first X number of feet to a larger diameter pipe with a consequently smaller headloss per foot. This would then yield a system that will give a balanced design; the pipe flowing to full capacity under the stated conditions, discharging the designed amount. This is the most economical type of approach and is the objective of a pipeline design.

Let's go back and review a little bit of some of the basic hydraulic theory behind the matters we have just discussed. The purpose of this review is to point our red lights in the design criteria that have been discussed, such as static and dynamic pressures, location of the hydraulic gradeline, flow conditions, and pipe discharges.

There are many pipeline projects, some of them working satisfactorily, others not so well. Some seem to work with confusing irregularity with surges in the discharge, frustrating blockages, etc. The reasons are easily explained under the principles we will discuss.

In the previous discussion, we have mentioned some criteria of design, one of which is the instantaneous flow rate. The flow rate and the slope of the HGL determine pipe size. Topography determines the pressure drop in the pipe, which is also a function of pipe size and flow rate, and fluid velocity in the pipe. The fundamental equation Q=VA has been developed elsewhere and holds true for the systems we are discussing. Q depends upon the velocity and the area of the pipe cross-section. Velocity (the average velocity) depends on the available head, the pipe roughness, and the pipe size. The area, of course, is dependent upon the pipe size.

Many, if not acquainted with hydrostatics, show confusion when it comes to discussing pressure. Unit pressure and head are the same thing. The static pressure in a pipe is independent of the pipe size. Head or pressure is another term for energy. If you remember your high school physics, you will remember the terms potential and kinetic energy. The potential energy in any fluid distribution system is the total head, or elevation difference. This is partially converted into kinetic energy, or the energy of the moving fluid. The friction within the pipe is another source of expenditure for the total potential energy. Potential energy is utilized to overcome pipe friction, and the amount utilized per unit of length is the headloss. In other words, fluid flowing through a pipeline loses head (energy) because of pipe friction. Any open-end pipe flow is a balanced system; all of the potential energy is utilized for imparting velocity to the fluid and overcoming friction within the pipe. We determined Q as a design criteria, and velocity is necessary to compute Q, so how do we find velocity? Velocity is a function of headloss, pipe size, and roughness and is determined by Manning's equation as shown:

$$V = \frac{1.486}{n} \times R^{2/3} S^{1/2}$$

, where S is the slope of the HGL,
n = 0.009 for plastic pipe, and
$R = \frac{Dia}{4}$

Nomographs solving this equation which show flow as a function of headloss and pipe size are available. The hydraulic gradeline is shown in Figure 1. The hydraulic gradeline represents the level to which a fluid would rise in an open tube pierced into the pipeline. The interval between the hydraulic gradeline and the pipe center line represents the pressure at that particular point within the pipe. Hydraulic gradeline can be straight or can be broken as shown. What causes a break in the slope of the hydraulic gradelines? A change in pipe size, a change in pipe roughness characteristics, or a constriction within the pipe. Thus, we can see why some of these pipelines do not work with any rationally described flow--either because of siphons, constrictions, or air locks.

Pressure Limits - All of the pipe we use is pressure rated at either 80 or 125 p. s. i. This means that the working design pressure for these particular pipes should not exceed 80 p. s. i. and 125 p. s. i. respectively. Pressure is another term for head. The conversion is 2.31 feet of head per p. s. i. Thus, we see that 80 p. s. i. pipe can withstand about 185 feet of head. What does this mean in terms of pipeline location? It demonstrates the need for an adequate ground profile to be possible to measure the interval between the pipe and the HGL. If you have an open-end pipeline, you must be careful not to exceed the design pressure of the pipe. With a closed-end system (which incidentally we rarely use because of our steep terrain), it will show the limits of allowable elevational differences for valving the end of the pipe. It may be necessary to install pressure reducing valves or head breaking boxes somewhere in the line if it is desired to have a closed-end system.

Installation Items - Seven simple installation considerations must be remembered:

1. First of all, it is presumed that these distribution systems will be operated on an intermittent basis and will be drained perhaps annually or maybe twice a year. Because of this, it is necessary to install vents below each drain valve, or below each valve that obstructs a line. Otherwise, there is danger that the line may collapse due to atmospheric pressure as the fluid evacuates the pipe.

2. During installation it is necessary to cushion these pipes before backfilling. Frequently, the urgent need is to just get something in the ground to do the job. A lot of unnecessary maintenance problems can be prevented if the lines are installed with some attention to preventing large rocks and obstructions bearing directly on them, thus preventing collapsed abraided lines.

3. We have found it prudent to mark the line locations with a half fencepost, a mound of stone, or a windrow of rock directly over the location of the buried pipe. This need is clearly demonstrated when necessary to dig up an old pipe after two or three years or longer, to either replace it, enlarge it, or repair it.

4. It is a good practice to unroll these plastic pipes rather than uncoil them. Plastic pipe uncoils into a helical pattern and is very difficult to install.

5. All portions of the line should be graded to drain to a drain valve, located somewhere along the line, and these drain valves should be installed at every low point.

6. It is necessary to "snake" these lines in the trench to allow for thermal contraction, particularly if they are installed during very hot weather. We have found that if the lines are installed in cool weather, we have less trouble with them shrinking and popping the joints. If water is put into the line before backfilling, it will tend to cool the plastic pipes until they are less likely to have thermal contraction problems. We try to avoid backfilling these plastic pipes until they are under pressure, thus eliminating possible collapsing of the lines.

7. Finally, if a design is made of a pipeline, and it is found necessary during construction to change the location of any of the pertinent works by any significant amount, either the location of the line itself or of troughs or valves, it is wise to check first with the designer to ascertain if there may or may not then develop problems due to the change.

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A woman traded her vacuum cleaner

for a telephone--

Claimed she could pick up more dirt that way.

COW COUNTRY 6-68

Information Concerning Results of Growing Small Burnet
on the
Manti-LaSal National Forest
By
James J. Butler* and Robert Thompson**

Small Burnet (Sanuisorba minor) is an introduced species from Europe where it is grown and used as a salad plant.

We have been including Small Burnet in our seed mixtures since 1965 when it was first planted on the Joe's Valley Big Game Range Mitigation Area. Since then, it has been included in mixtures for most all of our wildlife, range, and watershed treatment rehabilitation work.

Good seedling survival has been obtained on harsh sites in very poor soils, consisting sometimes only of a "B" horizon soil only. Soil material derived from sandstone with a sandy texture has been best, but seeding success has been good on a shale derived soil. Success on harsh Mancos shale derived soils has been good initially, but Small Burnet has tended to die off some and produced little viable seed.

Some new seedlings from seed have been found on the better quality sites.

Small Burnet is a very palatable plant and is heavily used by rabbits, deer, and elk. The rosettes of Burnet are grazed heavily by wildlife during late April, May and June. Burnet also stays green and palatable under snow for a short time, but tops freeze if the soil freezes. Deer and elk will paw under a foot of snow to get at the leaves. Seeds are used by upland game birds for food.

The plant generally grows to a maximum height of 18 inches and spreads out 9 to 12 inches at the base. It is succulent and appears to be fairly drought resistant.

In a mixture of grasses and other forbs, it seems to be a rather poor competitor and will disappear in three to eight years if competition for water is intense. One of its outstanding values is its ability to establish on harsh sites under conditions other plants will not germinate or survive under.

Our studies are continuing and in the future more about its survival on various sites will be known.

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*Branch Chief of Range, Wildlife and Watershed - Manti-LaSal N.F.
**Range Conservationist - Manti-LaSal N.F. (12/68).

Several additional references about Small Burnet are:

Agricultural Handbook 293, U.S.D.A.
Notes on Western Range Forbs
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Volume II, Hermann, F. J., pp. 34

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Volume 28, No. 4, October 1964
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Toth, McLain & MacNamara

Toth, S. J. & P. McLean (MaLain) 1961
Soils in Poor Barren Area Can Grow Cereal Crops
New Jersey Agr. 43(1): 4-7

There may be others.

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DON'T spoil tomorrow's plans

with

an accident TODAY.

* * * * * *

It is harder to be a good winner than a good loser--

One has less practice.